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The Early Iron Age Metal Workshop at Tell Tayinat, Turkey

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ABSTRACT

Scholars have tried to link the dramatic rise of iron production in the Near East during the Early Iron Age with changes to the political landscape that occurred at the end of the Late Bronze Age. These attempts have been hindered by a lack of excavated iron production contexts dating to the Early Iron Age. The recent discovery of an Early Iron Age metal workshop at the site of Tell Tayinat, Turkey, provides an opportunity to reexamine some previous assumptions. Preliminary chemical analysis of metal and slag samples indicates that during the 12th century BC iron- and bronze-working were not separate, specialized industries. Instead, production of both materials took place within the same workshop context. Furthermore, this work highlights the importance of prestige goods in the Early Iron Age repertoire.

INTRODUCTION

Smelted iron was in use in the Near East from at least the 3rd millennium BC, but it remained relatively rare until after 1200 BC when its use increased exponentially [1]. This date also marks a significant shift in the political landscape of the Near East. Around 1200 BC the centralized power of large territorial states, such as those of the Hittites and Egyptians, disintegrated, which gave way to a "balkanized" political landscape [2]. In southeastern Anatolia, the end of Hittite control from Hattuša led to the emergence of several independent Neo-Hittite states, such as Karkamiš and possibly Palistin [2]. Scholars have tried to link the dramatic rise in iron production with these political developments, but have had to rely solely on iron artifacts, since no iron production contexts in the Levant from the 12th or 11th century BC had been excavated. The discovery of an Early Iron Age metal workshop at Tell Tayinat, therefore, provides the first opportunity to study an iron production context in the Levant from the 12th century BC.

Tell Tayinat lies about thirty kilometers east of Antakya in the ʻAmuq Plain in southeastern Turkey near the present-day border with Syria. The ʻAmuq Plain served as an important intersection for trade in the ancient Near East, connecting the north-south land route through the Levant with a major overland route between Mesopotamia and the Anatolian highlands. During the Early Iron Age, Tell Tayinat became the capital of the Land of Palistin, one of the emergent Neo-Hittite states [2]. The Oriental Institute of the University of Chicago conducted excavations at the site during the 1930s. Renewed excavations were initiated in 2004 by the University of Toronto. In 2006, work began along the western edge of the site's upper mound, just inside a fortification wall originally excavated by the Oriental Institute. The remains of this mudbrick fortification wall were quickly identified, but unexpectedly an Early Iron Age metal workshop was also discovered.

The workshop can be divided into three rooms (see Figure 1). The southern Room 1 consisted of a semi-circular installation with a mudbrick platform built on top of a layer of sherds, bones, and stones. The installation measured 2.3 x 1.2m. A layer of ash surrounded the installation to the north and east and also covered the installation, sealing against the wall to the west. In the northern Room 2, five ash deposits, each about 50cm in diameter, formed an "L-shaped" pattern in the southwest corner of the room. The deposits were spaced approximately 75cm from the center of each deposit and in the northeast corner was a trail of ash. In Room 3, the eastern half of which was destroyed by later building activity, several slag cakes were found deposited in a semi-circle in the southwest corner of this room. Significant amounts of slag, copper and iron fragments, tuyère and crucible fragments were recovered from each of the rooms. The workshop has been dated to the Iron IA period (12th century BC), based on the associated pottery. The most diagnostic characteristic of the pottery is the presence of Mycenaean IIIC1-style painted ware [3]. Red-Slipped and Burnished Ware, the dominant pottery tradition of the succeeding Iron II period, was absent from the workshop levels. The associated material culture thus dates the workshop securely to the Early Iron Age, or more specifically the Iron IA period.

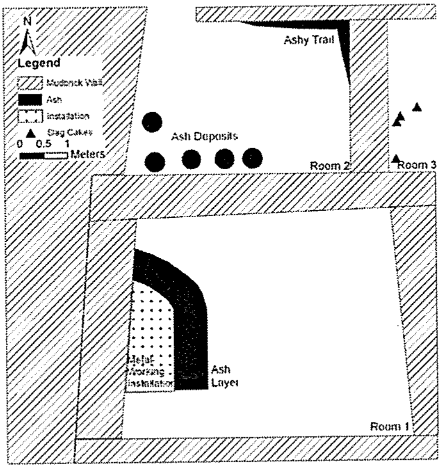

Figure 1: The Tell Tayinat metal workshop.

EXPERIMENT

Six slag samples and two metal samples from the Tayinat metal workshop were analyzed in the X-ray Fluorescence Spectometry (XRF) Laboratory of the Department of Geology at the University of Toronto. The surface of each sample was analyzed using the Semiquantitative™ (or Standardless) software package. This method was used because of the small size of the samples analyzed. The software allowed for the recalibration of results to a sum of 100% in order to compare samples of different sizes. The samples were not homogeneous and the probable depth of penetration of the primary X-rays was only 20-200 μm below the surface. Therefore, these results should be seen as a preliminary characterization of the assemblage and caution is necessary when interpreting them. Samples SA969 and SA2125 were cleaned using a hydrochloric acid bath to remove surface concretions.

DISCUSSION

<u>Slag</u>

Four of the analyzed slag samples were the product of bronze-working (SA966, SA1679, SA2125 and SA2155 in Table I), and two were the result of iron-working (SA2118 and SA2147 in Table I). Sample SA966 was slag adhering to the inside of a crucible fragment found in Room 1. Sample SA2155 from Room 3 was also slag adhering to a crucible fragment, near the rim. Both of these were identified as bronze slags since there was a significant amount of tin (Sn) in addition to copper (Cu). Sample SA2125 was a copper prill from Room 2, which also contained a significant amount of Sn. Thus, there was evidence for bronze production in all three rooms.

Table I: Results of XRF analysis on slag and metal samples from the Tell Tayinat metal workshop. A single measurement was taken on each sample.

	Slag Samples						Metal Samples	
	SA966	SA1679	SA2118	SA2125	SA2147	SA2155	SA969	SA1314
Al	9	4	6	3	7	9	3	4
As	0.05		0.02	0.2		0.1		0.1
Ba	0.1		0.03		0.1	0.2		
Ca	28	5	11	0.02	34	19	1	6
Ce		0.08						
Cl	0.04		0.06	1	0.03	0.07	4	0.2
Co	0.01					0.2		
Cr	0.08	0.1	0.02	0.4	0.2	0.2	0.07	0.05
Cu	0.9	0.02	0.3	20	0.1	8	25	39
Fe	10	11	55	3	18	14	2	4
K	1	5	0.6	0.2	0.6	1	0.5	0.3
Mg	4	0.6	4	5	3	3	2	2
Mn	0.2	11	0.08		0.2	0.3	0.03	0.02
Na	0.5	1			1			
Nb	0.004	0.1						
Ni	0.05		0.04	0.09	0.05	0.1	0.03	0.02
P	1	0.2	1	0.02	0.9	3	0.1	0.8
Pb	0.09					1	0.2	
Rb	0.009	0.003			0.006	0.006		
S	0.3	0.4	0.1		0.2	0.2	0.3	0.07
Si	43	21	22	57	34	39	59	33
Sn	0.3	0.01		10		0.7	2	10
Sr	0.1	0.02	0.02	0.09	0.1	0.1		
Ta		0.03						
Th		0.007						
Ti	0.8	41	0.2		0.8	0.8	0.3	0.2
V					Low	0.08		0.08
Y		0.007						
Zn	0.01	0.01	0.02			0.05	0.03	
Zr	0.02	0.2				0.02	0.01	

Interpretation of the analytical results of sample SA1679 was more difficult than the others. Sample SA1679 was a black, glassy slag sample with an unusually high amount of titanium (Ti). Not only did this slag sample contain more than 41 percent Ti, but it also contained niobium (Ni). This association is indicative of the mineral rutile. Our hypothesis is that rutile was not being smelted intentionally, but since rutile is similar in appearance to cassiterite and usually shares a common geological source, this slag sample appears to represent a failed attempt to smelt cassiterite at the site. Unfortunately, this slag sample was not found in the metal workshop itself, but it did come from a contemporaneous Early Iron Age context in another area of the site.

Evidence of iron production came from two of the slag samples analyzed. Sample SA2147 was taken from one of the slag cakes found in Room 3. In addition to iron (Fe), this sample contained chromium (Cr), manganese (Mn), nickel (Ni), vanadium (V), copper (Cu) and titanium (Ti). The mineral magnetite is often enriched with these elements. It is unclear what stage of the iron-working process produced this slag cake. Smithing hearth bottom slag cakes [4] were identified from the workshop based on their concavo-convex shape, and a size of approximately 6cm in diameter and 1cm in thickness. However, the slag cakes found in Room 3 have a plano-convex shape and are larger, at over 10cm in diameter and 3cm in thickness. Future work will try to answer whether these two different types of iron slag cakes represent different iron-working processes, such as forging and secondary smithing.

Sample SA2118 was identified as a slag prill, perhaps spheroidal hammerscale [5], which had both iron and copper content. Although macroscopically SA2118 appears to come from iron production, its 55 percent iron (Fe) content is consistent with slag from either iron or copper production. The crux is in interpreting its content of approximately 3000 ppm of copper (Cu). Similarly, sample SA2147 contained approximately 1000 ppm Cu. Considering the shallow penetration of the primary X-rays in the technique used, the copper content could perhaps be the result of post-depositional contamination from a copper-rich environment. Alternatively, the copper could be part of the actual slag material. These amounts of copper would appear high for iron slag. Iron slags from Tell Hammeh, Jordan and Tel Beth-Shemesh, Israel contain copper in the range of 20-60 ppm [6: 194, Table 2]. However, R.F. Tylecote has argued that copper smelting slags, even modern examples, usually have copper contents exceeding 5000 ppm [7]. Thus, although the copper contents in samples SA2118 and SA2147 are high for iron slag, they appear too low for copper slag.

Additionally, flake hammerscale [5] was recovered from Room 2. A 20 x 20cm fine grid was set up in this room in order to collect soil samples for further analysis. Magnets were used to recover the small flakes of hammerscale from each of these soil samples. The distribution of this hammerscale is shown in Figure 2.

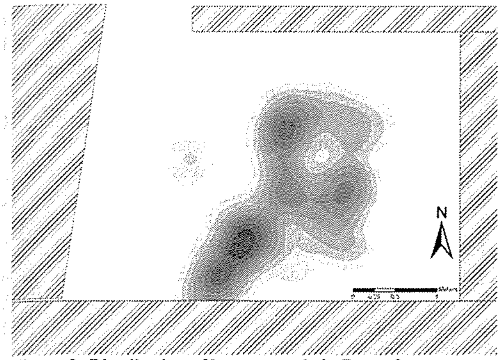

Figure 2: Distribution of hammerscale in Room 2.

The slag analysis thus indicates that iron smithing, copper melting and possibly copper alloying all occurred in the workshop and that both iron and bronze were worked in all three rooms. While there was some separation of certain features within these rooms, there was no clear separation between iron- and bronze-working remains.

Metal

Two copper-based samples from the workshop were analyzed using XRF (SA969 and SA1314 in Table I). While I have classified these as metal samples, because of the shallow penetration of the primary X-rays in the technique used, only the corrosion products of these copper-based metals were analyzed, not the original metals. Sample SA1314 had a high Cu:Sn ratio of 4:1 and a minimal amount of arsenic (As). Sample SA969 had a lower amount of tin, with a Cu:Sn ratio of about 13:1, and no arsenic. Because of the shallow penetration of the primary X-rays and the different weathering rates of copper and tin, these ratios are not indicative of the original composition of the metal. Instead, they are included here to demonstrate that a significant amount of tin was present, while arsenic was not.

Most of the metal pieces collected from the workshop were too fragmentary to classify, but some interesting observations can be made from those that were identifiable. A similar number of copper and iron artifacts were identifiable. The ratio was ten iron artifacts to twelve copper artifacts. More importantly, there was a complete overlap in the artifact categories for both metals. Iron artifacts included weaponry and armor (projectile points and armor scale), tools (a chisel, a needle and a nail) and even a piece of jewelry (a pendant). Similarly, there were also copper artifacts in all three of these categories: weaponry and armor (a projectile point and armor scales), tools (reamers), and jewelry (pins, a ring and a fibula).

Caution is necessary not to draw too many conclusions from such a small sample size. However, the metal artifacts from the Tell Tayinat metal workshop fit well with what should be expected during this time period when supplemented with contemporary data, which shows iron jewelry remained more numerous than iron weaponry or iron tools throughout the Early Iron Age [1]. Metal workers were making a variety of types of goods in both copper and iron. Weaponry and utilitarian tools were being manufactured alongside prestige goods, such as jewelry.

Refractory materials

In addition to the metal and slag materials already discussed, the workshop also contained refractory materials including 58 tuyère fragments. The tuyères can generally be divided into two types: round and square. Both types were similar in fabric and size. Fragments of eighteen round and nineteen square tuyères were recovered, along with twenty-one that were could not be classified. The bore holes were generally 1cm or smaller, unless the back-end was preserved, in which case the bore started at 2cm. Outer diameters of the tuyères ranged from 3 to 8cm. The longest preserved tuyère, at approximately 15cm in length, was elbow-shaped. No complete tuyères were found, so it is unclear what the full length of these tuyères was. However, the square tuyères have close parallels at Tell Hammeh, Jordan [8] and Tel Beth-Shemesh, Israel [6: 196].

In addition to tuyères, the refractory materials included both crucible and furnace fragments. It was often difficult to distinguish between these two groups, but the preservation of complete rims with slag adhering on the inside was interpreted as indicative of crucible remains. The crucibles were generally low-fired and highly friable. This latter characteristic appears to have been intentional, as macroscopic analysis indicated that chaff was used as a tempering agent in the construction of the crucibles. Many furnace fragments were also recovered, but the poor state of preservation did not permit for the reconstruction of a furnace structure.

CONCLUSIONS

Although analysis of the Early Iron Age metal workshop at Tell Tayinat is not complete, and the results presented here are therefore preliminary, they nevertheless permit a number of observations. In particular, the analytical results point to the existence of a non-specialized metal workshop involved in the production of both iron and copper goods of a variety of types. Iron smithing and the melting of copper occurred. A wide variety of activities were carried out in this small workshop with no discrete activity areas for any given specialized activity. Thus, it appears, at least in this area, that early iron-workers were also bronze-workers, and that craft specialization had not yet fully separated these two activities in the Early Iron Age. Furthermore, the variety of goods produced indicates that these metalworkers were producing both prestige and utilitarian goods made from both metals. Future studies need to take into account that prestige goods remained an important component of the Early Iron Age repertoire.

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